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Innovative Applications of O.R.

An optimization approach to designing a baseball scout network

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ABSTRACT

We study the problem of assigning and scheduling minor league scouts for Major League Baseball (MLB) teams. There are multiple objectives in this problem. We formulate the problem as an integer program, use decomposition and both column-generation-based and problem-specific heuristics to solve it, and evaluate policies on multiple objective dimensions based on 100 bootstrapped season schedules. Our approach can allow teams to improve operationally by finding better scout schedules, to understand quantitatively the strategic tradeoffs inherent in scout assignment policies, and to select the assignment policy whose strategic and operational performance best meets their needs.

1. Introduction and literature review

Major League Baseball (MLB) is a 30-team North American professional baseball league. Minor League Baseball (MiLB) is the hierarchy of developmental professional baseball teams for MLB; most MLB players first develop their skills in MiLB. All MiLB teams have an affiliation with one of the MLB teams. An MLB team and its affiliated MiLB teams form a franchise.

MiLB consists of six levels: Triple-A (AAA), Double-A (AA), Class-A Advanced, Class-A, Class A Short Season and Rookie, and players progress up through the levels as they develop. Each level is divided into 2 to 4 leagues. Fig. 1 shows the Minor League classification of levels and leagues.

The MiLB season typically starts in April and ends in September. The teams play almost every day, with occasional single days off. Pairs of teams in the same league play against each other several games in a row (called 'series', 2 to 5 games depending on the league) to reduce travel costs, usually at least one series at each team's home stadium. Teams that belong to different leagues do not play against each other. In 2012, there were 187 MiLB teams based in 173 cities (see Fig. 2) and the season consisted of 10,756 games.

Each MLB team employs scouts, experts who evaluate the strengths, weaknesses, and overall potential of players. In this paper, we concentrate on the scouts who monitor the development of players on all MiLB teams, including those affiliated with the scout's MLB team. Throughout the season, scouts travel from one game to another observing and evaluating players. Scouts' travel schedules are determined by hand and can be very hectic, so a MLB team presented us with the opportunity to study the problem of optimizing their MiLB scout schedules.

The most important element of scout scheduling is that scouts should have the opportunity to (collectively) evaluate all of the important players in MiLB. Key players of each MiLB team should be watched at least once during the season, and it is desirable for all such players on a team to be seen by the same scout. Because starting pitchers pitch once every five games, the scouts are implicitly required to see at least five games of each team during the season. Watching all the starting pitchers on a team will most likely satisfy the constraint to see all other significant players too, unless a player is injured.

There are several objectives in scout scheduling. Assigning scouts to concentrate on multiple teams at the same level allows more reliable comparisons to be made by the scout (horizontal visibility). On the other hand, it is also beneficial for a scout to monitor the development of the players in the same franchise as they progress through the levels (vertical visibility). A representation of these two competing objectives can be seen in Fig. 3. Finally, minimizing the costs of scout travel (transportation and lodging) is also a desired objective.

In general, the question of routing scouts around the country to collectively see each team is similar to the vehicle routing problem (VRP, see Laporte, 1992; Toth & Vigo, 2001). However, there are three primary properties of this problem that make it more complex than a generic VRP:

- *Mobility:* the teams are not stationary. Each team plays approximately half of its games in its home city, and the other half are divided among the cities of the other teams in its league.

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Fig. 1. MiLB levels and leagues.

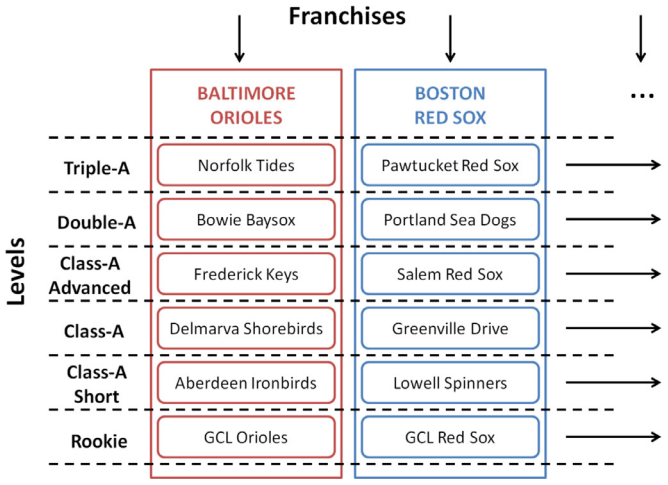

Fig. 3. MiLB organization, showing horizontal and vertical visibility.

- *Diverse repetition:* each team must be observed five times, and the set of five games must be selected so that each starting pitcher is seen once.
- *Double viewing:* a scout who sees a game can evaluate players on both teams in the game.

There is no literature we are aware of that addresses all of the complexities of this problem. However, combinatorial and integer optimization techniques have been applied to related problems in the sports industry. Easton, Nemhauser, and Trick (2003); Nemhauser and Trick (1998) and Trick (2003) use integer and enumerative techniques to create game schedules for leagues, a problem that deals with a related type of mobility property. Rasmussen and Trick (2008) presents a comprehensive survey on the literature considering round robin tournaments. Scheduling of umpires has properties similar to double viewing and (sometimes) mobility. Trick, Yildiz, and Yunes (2012) addresses the umpire scheduling problem (USP) in Major League Baseball using both exact and heuristic optimization methods, Duarte, Ribeiro, Urrutia, and Haeusler (2007) proposes a heuristic approach to solve a simplified version common to many amateur soccer, baseball and basketball leagues, Farmer, Smith, and Miller (2007) automated the scheduling of umpire crews for professional tennis tournaments, and (Wright, 1991) examined the scheduling of cricket umpires.

Among this work, umpire scheduling and its variants are the most relevant ones to us in terms of constraints that umpire crews must follow. In the MLB umpire scheduling problem (MLB-USP), the umpires are assigned to a previously defined schedule of games to be played by the teams. The goal of the umpire scheduler is to minimize the miles that each crew travels, without working more than 21 consecutive days. Other aspects of the problem are different; for example, according to MLB-USP, a crew must not umpire more than four series played by any team during the entire season, but do not have diverse repetition requirements, nor the complexity of the horizontal and vertical objectives. Therefore, the more-recent solution approaches to USP such as specialized

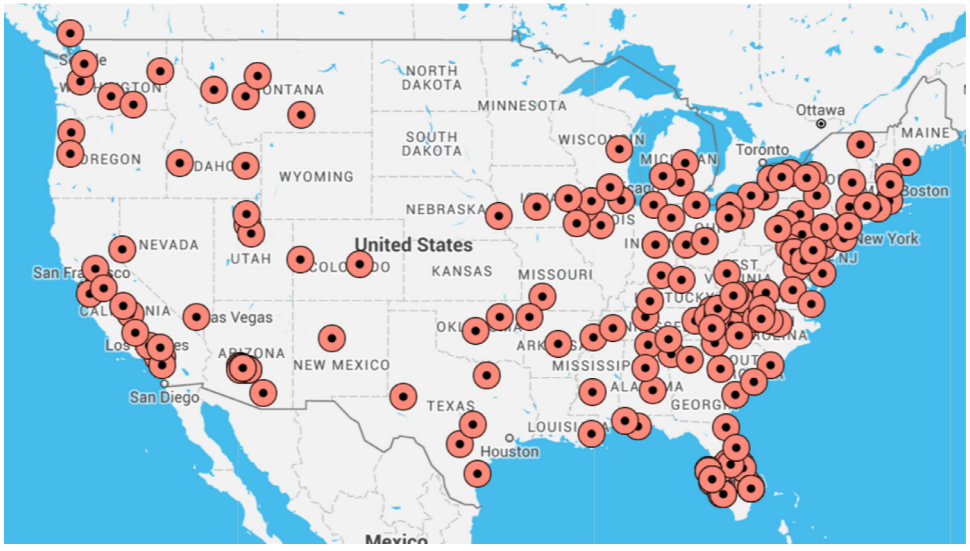

Fig. 2. Minor League team locations.